

ORGANIC FUNCTIONS IN SCHIZOPHRENIA

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As has been emphasized elsewhere,¹ there is need at present for a systematic determination of the organic characteristics of a representative group of schizophrenic patients. The data should be collected in such a way as to assure sufficient homogeneity to permit productive correlation studies among them. A method designed to meet this need has been described in another contribution;² to date sixty-four patients have been subjected to the seven months' study schedule therein discussed.

The trends of the study will be summarized by means of a table showing the average value and the variation of each of about fifty functions and by an illustrative case history. The case presented does not purport to conform to the average in all respects—no single case in the series does—but it is representative in showing the degree of variability with which we were confronted, as well as, in general, the deviations from normality that were found to be characteristic.

REPORT OF CASE

History.—H. E. C., an unmarried white man, aged 31, an American, a Protestant, a machinist and farm laborer, born on July 27, 1901, in a small manufacturing town in Massachusetts, the second of eleven siblings, was admitted to the Worcester State Hospital on July 11, 1931. Both grandmothers died of cancer. The paternal grandfather died of "shock." It was said that there were no nervous or mental diseases in the family, though both the paternal and the maternal ancestors were considered "wilful." The father was described as "mentally dull" and "stupid," and as having a poor memory; the mother as fairly intelligent. Two

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1. (a) Hoskins, R. G.: An Analysis of the Schizophrenia Problem from the Standpoint of the Investigator, *J. A. M. A.* **97**:682 (Sept. 5) 1931. (b) Hoskins, R. G., and Walsh, Anna: Oxygen Consumption ("Basal Metabolic Rate") in Schizophrenia: II. Distributions in Two Hundred and Fourteen Cases, *Arch. Neurol. & Psychiat.* **28**:1346 (Dec.) 1932.

2. Hoskins, R. G.; Sleeper, F. H.; Shakow, D.; Jellinek, E. M.; Looney, J. M., and Erickson, M. H.: A Cooperative Research in Schizophrenia, *Arch. Neurol. & Psychiat.*, to be published.

siblings died in infancy, and one from an injury to the head at 2 years. Eight siblings were living. The father stated that all his children were "silly"; they had never played with other children, having lived on a farm away from other homes. One sister had not worked outside the home because she had not been able to find an occupation that suited her. One brother, who worked on the farm, had a "silly grin" and was said to look "peculiar." Only one sibling was married, and all but he (and perhaps a sister) lived at home.

The birth and early development of the patient had apparently been normal. He had had the usual diseases of childhood, and had had no illness of any consequence in adult life. He started to school at 6 and completed the first year in high school at 15. He attended a boys' trade school for one year, learning carpentry, but was taken out of school because he was needed at home. Progress was satisfactory, and he was said to have enjoyed attending school. He began work at 15 on his father's farm. For the next five years he worked as a farm laborer; then for about eight years he worked as a machinist at \$20 per week. His foreman reported him as always quiet and reserved, and as shunning his fellow workmen. Just before he left this job his peculiarities seemed more pronounced than before. From March to October, 1930, he worked on a beet farm. From October, 1930, to admission he was not employed.

In childhood he did not seem to care to play much, but was always working around the farm; he took care of his younger brothers and sisters, and always appeared much older than the rest of the children. He was gentle, but never affectionate. He always had a tendency to be solitary and never knew how to make friends. He talked very little. He was considered self-willed and occasionally became sulky if thwarted, but was generous and good hearted. He rarely made social contacts outside the home circle or at work, and took no part in group activities. He had little recreation other than listening to the radio and reading the newspapers.

He was described as being honest and clean; he did not smoke, drink or swear previous to the onset of the present illness, and was a regular church-goer. He worried considerably about possible future misfortunes for the family, and about a small lesion on his lip, thinking it might be cancer. He said that "everything he wanted to do turned out just the opposite." He always was much discouraged when he met with failure. He was said to have been in love with a girl at the factory where he worked in 1926. She married another man, but even after this the patient bought engagement and wedding rings and continued speaking about marriage to her. Otherwise his heterosexual interests seem to have been greatly restricted. He had been away from home for only one week in his entire life. There was no history of a previous attack of mental disorder.

On April 7, 1929, the patient came home exhausted, hot and worried because he was not perspiring. Following this he was "not quite himself"; he became "jumpy" in his movements and somewhat irritable. About two years before admission, he had imagined that the family had plenty of money; he now said that he did not have to work and was going to buy a number of automobiles.

In September, 1929, he became very irritable; he began to go to the movies every night, and would see the same picture five or six times. He wanted to be doing something all the time and would not rest; he began to express certain dislikes, particularly in regard to the behavior of the family. He also spoke of seeing more people in the room than were actually there.

At Christmas, 1929, he seemed to be afraid of the red lights on the Christmas tree; he kept staring at them and mentioned that the lights stood for rubies. In January he began to speak about going into the movies; he bought some fancy

underwear and a suitcase, and spoke of making arrangements for getting to New York. Whenever the telephone rang he said that he was getting a call from the movies. He kept at work until the end of December, 1929. From January to March, 1930, he sat in a chair silent for long periods of time. He continued to visit the movies frequently. In March, he went to work on a beet farm. For five weeks he worked twelve hours daily, including Sundays, but thereafter for the usual number of hours. In October, he attended a church convention. On returning home he could not be persuaded to enter the house; he said that something terrible was going to happen at 9 o'clock, that his brother was going to be put into a pit and have his eyes taken out; after 9 o'clock he cried and prayed and repeated, "God save us," this lasting throughout the night. For the next two or three days he watched the mirrors, was very frightened and excited, and thought that he was being grabbed. He refused to eat for three days, claiming that the food was poisoned. He was sent to stay with nearby relatives and seemed to recover from this acute episode. From this time on, he sat about the house indifferently, helping in churning the butter and peeling potatoes and taking part in games reluctantly. For three months previous to admission he talked with his hands and did not want to answer questions. About twice a week he became disturbed; he became angry and cursed his brothers. He thought that he ruled the universe, that he was capable of doing almost anything, that everybody knew what he was doing, that he was watched constantly. At times he appeared to be very depressed. At other times he grinned in a silly way. After the family refused to allow him to frequent the movies, he began to read the Bible. For three weeks previous to admission, he imagined that his father was wealthy, and demanded \$1,500 of him; he attempted to strike his father when the money was refused. Shortly before admission he imagined that he was an actor in the movies, and after seeing Harry Green on the screen he identified himself with that character. Colors seemed to bother him considerably. After July 4, 1931, he was disturbed; he threw furniture about the house and attempted to strike his parents. He said that he was afraid to talk because he feared his remarks would be broadcast. He spoke of a camera which could take pictures ten miles away and which was photographing him. He believed that the Board of Commerce was behind some of this activity. He said that his brother-in-law (he has none) came into the house by means of electric wiring. He admitted to his mother that some of these ideas were foolish, but he could not get them out of his head. On July 11, 1931, when driving the family car, he became excited, swore, repeated things over and over again and broke the glass in the door. He was then taken to the hospital without resistance.

Examination.—On admission, the patient was neat, clean and tidy, and answered questions readily and coherently. He was oriented for place, but gave the date as March 23, 1930 (it was July 11), and said that he could see the sun shining at 10:30 p. m. No other hallucinations were disclosed. He showed some impairment of memory. He had no apparent insight.

Physically, he was essentially normal, except that the entire upper set of teeth were missing and only six lower teeth were present. Laboratory tests gave essentially normal results.

Mental Status.—On July 15, 1931, the patient was cooperative and seclusive. He did a little work in the ward occasionally, was quiet, grinned in a silly fashion at times, answered questions readily and coherently, talking spontaneously, and seemed abstracted. At times his replies were irrelevant, and he was thought to show a flight of ideas. He seemed somewhat indifferent. He expressed a belief that he was a bad man and could not be trusted, that nobody could go bad unless he went bad, that he would live as long as the world was good, that he could travel

80,000,000 miles an hour through space and electricity, that he could pass through a crack in the floor, that he could hear everything that went on, and that he had told "them" what "they" did not know. He was well oriented in all spheres. He was not cooperative about questions involving memory and general information. He gave the date of his birth as July, 1900 (correctly, July 27, 1901), and said that he began work before he was born. When asked if he was married he replied that "marriage is not allowed in this state." He said that he completed his senior year in high school (correctly, first year high school); that the Declaration of Independence was never made, that the war began in the year 1 over religion, and that the Gulf Stream is where they started playing golf. Judgment was considered poor, and he was thought to have no insight into his condition.

Course.—On July 17, at a staff meeting, the patient seemed to be at a loss to express himself. He blamed his father for many of his difficulties. He said that he had felt for a long time that he was different, that if he had been told in more detail about the differences in the sexes of things he would never have been taken sick and would never have come to the hospital, and that he could not get on with women. He was under considerable emotional tension as he related this and as he talked of his family. He stated that unknown people were annoying him by manipulating his genitals and accusing him of sexual perversions. He seemed to realize that he was ill, but felt that his ideas of persecution were not imagination.

In the wards he was seclusive and reluctant to work. He stood about in corners, looking depressed and anxious. He rarely spoke unless addressed, and was reluctant even to talk to relatives when they visited him; he thought that the hospital was trying "to get something on him." He spoke cryptically of first and second gods. He said: "I'm under space. I'm beyond existence." He said that he had existed since the beginning of time, which was one billion years ago, and that now was the first day the world had existed, and that was why he was there. There seemed to be some change in his delusional ideas from day to day, except that he kept insisting that he was Satan.

On July 20, he was transferred to the research service.

On July 29, the patient was evasive or actually blocked on certain subjects, particularly sex. He gave relevant replies to questions; he had much difficulty in expressing himself accurately, but the stream of talk was coherent. He was slow and deliberate in movements and speech. His facial expression was almost unchangingly dull and stupid. Such emotional reactions as were shown were not incongruous. From the rather elaborate material recorded, a few further items may be excerpted. They afford many suggestions for a "dynamic" analysis, but bear less directly on the theme of this article. The patient discussed various aspects of the case history with considerable freedom, mostly rationalizing them fairly plausibly. He doubted the actuality of his family relationships. He complained about being "mobbed" by girls—referring to hallucinatory scurrilous voices. He expressed further convictions that his family were to be tortured and that he himself frequently was being tortured. He complained that detectives followed him because he had committed many crimes, and that people on the street made remarks about him. His delusions of persecution included also poisoning. The delusions were not systematized. His ideas of influence were of the classic type—mind-reading and outside control. His hallucinations were both auditory and visual; the latter included a vision of God. Possibly a belief he held that he was smothered at night by crude oil and naphtha was hallucinatory, possibly delusional. Orientation for time was somewhat defective, but that for person and place was accurate. Remote memory was intact; memories of recent events were not well preserved; retention was fair. School and general information was limited, and he showed

but little contact with current events. Counting and calculation were adequate for simple problems. His capacity for thinking was thought to be rather subnormal. Judgment was markedly defective. He showed a little insight—"Maybe in a way I'm crazy . . . I can't control myself."

Diagnosis and Prognosis.—At a staff conference on July 31, a formal diagnosis was made of schizophrenia, with the majority of the staff favoring the catatonic type. One member preferred the paranoid type. A formal prognosis was given of institutional social adjustment under ordinary care, with considerable possibility of social recovery with intensive therapy.

First Period of Study (August 2 to 27).—No essential change was noted during this period. The mental state at the beginning was considered essentially the same as on July 29, 1931. The patient was fairly friendly and cooperative; he expressed a dislike for the tests; complained about the tests to his relatives, but submitted placidly; refused to swab, but worked well otherwise; spent a great deal of time in a rather manneristic pose about the ward, and always seemed to be self-absorbed and somewhat withdrawn from the environment. The predominant mood throughout was one of indifference. No new ideational content was uncovered. His condition remained fairly constant at the level of institutional adjustment.

First Period of Rest (August 30 to October 24).—During this period the patient became somewhat more silent and inaccessible, though also more observant, and he maintained better contact with his surroundings. The total change, however, was slight and was regarded as inconsequential.

Second Period of Study (October 25 to November 21).—On the whole the patient was submissive to tests, but he did not cooperate actively and tended to be suspicious and to protest about them. His behavior in the ward remained rather stereotyped throughout. He was seclusive, took little part in the activities around him, and was usually to be seen leaning against the wall in a characteristic pose with his legs widespread, apparently observing what was going on. He was orderly and well behaved except for periods of irritability when he obviously wanted to be left alone. He usually did no work in the ward, and swabbed only occasionally, had the attitude that ward work was beneath him and could not be interested in occupational therapy. Throughout the entire period he was obviously antagonistic, suspicious and uncooperative. He frequently railed against the hospital and the tests, but now and then was seen to smile. He seemed to appreciate special attention and to respond to it somewhat. He did not show any great interest in his relatives and always seemed to harangue them at considerable length on the necessity of taking him home. On the whole, his condition at the end of this period of study seemed worse than it was at the beginning. His paranoid reactions had become more acute and the catatonic features less prominent. He was less cooperative, less accessible and less responsive.

Second Period of Rest (Nov. 22, 1931, to Jan. 16, 1932).—Throughout this period the patient's behavior was much the same as during the second period of study, except that he did not show the irritability and antagonism that were marked then, nor did he rail so loudly and bitterly about his confinement in the hospital. He seemed to be accepting hospitalization as something which, though undesirable, was inescapable.

Third Period of Study (January 17 to February 13).—Activity remained at a low level. The patient gave the impression of being dull and uninterested, though fairly observant. He was evasive and found difficulty in expressing himself. His stream of talk showed irrelevance and disconnection. His mood was apathetic, with

traces of suspicion and resentment. He became rather more manneristic in conduct. His mental content was characterized by a wealth of delusions and hallucinations. He had paranoid ideas about the hospital; believed himself followed by a clairvoyant; said that he was surrounded by machinery; reiterated his idea of being a bug, and pointed out his wings to the examining physician; spoke of olfactory hallucinations, of hearing the voices of people who said, "Get out of here" and accused him of stealing; and said that he could see at a distance of 5 miles, that he had seen God in burning bushes and that he could see spirits moving about. It was difficult to determine impulsions, compulsions or obsessions. Orientation seemed defective, but could not be satisfactorily determined. Remote memory seemed defective, and the patient did not appear to have much insight into his condition. Altogether, at this time the paranoid and catatonic features seemed to be about equally prominent.

Summary.—A farm boy, a member of a rather isolated, "queer" family, had succeeded in making a fair vocational adjustment and one abortive attempt at heterosexual adjustment. After a period of growing tension, in which suspiciousness and a certain amount of grandiosity were apparent, at the age of 31 he experienced a panic reaction which brought him to the hospital. At this time he showed such schizophrenic features as irrelevance and delusions of importance and power, of influence, of persecution and of reference. He was rather retarded and apathetic. He had hallucinations in the auditory and visual and perhaps olfactory fields. The case was classified as schizophrenia, with both paranoid and catatonic coloring, the latter predominating. During the three periods of study and the two intervening periods of rest there was relatively little change in the clinical picture, except that the paranoid coloring and emotional tension seemed rather more pronounced in the middle than in the first and last periods.

ORGANIC FINDINGS

In table 1 is set forth a summary in statistical form of the findings in the first fifty-seven cases studied as regards about fifty of the organic variables. Several additional functions were investigated, but the results do not lend themselves to tabular presentation. They included tests of bromide permeability, autonomic irritability, sedimentation rate of the blood and hepatic functions. The vasomotor efficiency was repeatedly studied by the Schneider method, and numerous tests were made of the effect of the blood serum on *Lupinus albus*. Some of these special studies will be separately and individually reported.

The findings will be taken up seriatim as regards the illustrative case history and they will be compared with the averages for the entire series. The group averaged 31.7 years in age. As indicated by the standard deviation of 7.1, two thirds of the cases fell into the age period from 24.6 to 38.8 years. The youngest patient was 19 and the oldest 45 years of age. The patients had been in the hospital, on

an average, five and nine-tenths years. The figure was thus not entirely representative; the average stay of schizophrenic patients in the state hospitals of Massachusetts is about eleven years. Chronic cases of longer duration were relatively scantily represented. Likewise, we had relatively few cases of the disorder in the early acute stage. The group as a whole represented predominantly the stage at which the psychosis has become well defined, but before deterioration has progressed far—in short, the period at which the manifestations are perhaps most characteristic.

A physical examination was made according to a formal schedule (regional), in which data on one hundred and sixty-four specific features were recorded. In addition, any rare abnormalities not provided for in the schedule were noted. The examination was repeated at the beginning of each of the three subperiods of the study. By and large, the physical findings in the total group were not greatly abnormal. The weight was commonly below prediction, the average "nutritional index" being 84 per cent of normal for the age and height. Few patients in the series were significantly overweight. Occasionally the pubic hair was scanty or of the feminine type of distribution, but for the most part evidences of dysplastic constitution were lacking. The pupils occasionally showed irregularities such as other observers have frequently reported, and cyanosis or coldness of the extremities was often observed; the ordinary reflexes, such as the knee jerk, were also often exaggerated or depressed. The only other gross abnormality that occurred with noteworthy frequency was poor teeth.

Physical Examinations.—H. E. C. was normal physically, except that there were at times oval pupils, a palpable thyroid isthmus, slight cyanosis of the hands and feet, diminished tendon reflexes, an absence of pharyngeal reflexes and slight limitation of motion of the ankles, with transient edema. Twenty teeth were missing, and two of the remainder were carious. Roentgen studies brought out no abnormalities except colonic stasis and a little thickening of both hili of the lungs, suggestive of old healed tuberculosis.

Basal Metabolic Rate.—Table 2 sets forth the data in the case of H. C. L. that are particularly related to the rate of oxygen consumption. These constitute what might be called the "respiratory complex." The "basal rate" recorded is the average of the calculations based on the Harris-Benedict and the Aub-Dubois methods. The rate is expressed directly in percentage of normal rather than by the awkward use of "plus" and "minus" signs. The calculations were independently checked throughout. In each case the attendant recorded a note as to the conduct of the patient during the preliminary period of rest and the metabolimetrist during the tests. The items specifically noted were the degrees of muscular quiescence, of vigilance, of apparent nervous tension and of regularity of pulse and of respiration. The pulse rate was recorded during the first and last portions of the test and the respiratory rate three or four times during its progress.

Rectal Temperature, Pulse Rate and Respiratory Rate.—These were recorded in a routine manner by nurses or attendants twice daily, in the early morning

TABLE 1.—Means and Variation of Organic Functions Determined in Fifty-Seven Patients in "Seven Months Plan"

Variable	First Period		Second Period		Third Period		Mean All Three Periods
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Age, years	31.7 ± 0.59	7.1 ± 0.42					
Stay in hospital, years.....	5.9 ±						
Weight, Kg.	62.7 ± 1.0	6.6 ± 0.71	62.5 ± 0.81	9.0 ± 0.58	62.7 ± 1.03	9.8 ± 0.73	62.6
Height, cm.	172.9 ± 0.75	7.2 ± 0.53	172.9 ± 0.75	7.2 ± 0.53	172.9 ± 0.75	7.2 ± 0.53	172.9
Morning temperature (rectal, F.).....	97.5 ± 0.02	0.19 ± 0.012	97.6 ± 0.02	0.26 ± 0.022	97.7 ± 0.03	0.31 ± 0.02	97.6
Evening temperature (rectal, F.).....	98.9 ± 0.02	0.26 ± 0.016	99.0 ± 0.02	0.19 ± 0.012	99.1 ± 0.02	0.23 ± 0.014	99.0
Basal pulse rate.....	59.2 ± 0.82	6.14 ± 0.36	59.0 ± 0.83	7.6 ± 0.45	59.4 ± 0.72	7.4 ± 0.51	59.2
Basal systolic pressure, mm. Hg.....	105.3 ± 0.77	15.78 ± 0.54	99.6 ± 0.70	14.33 ± 0.50	100.5 ± 0.77	15.6 ± 0.54	101.8
Basal diastolic pressure, mm. Hg.....	65.5 ± 1.33	13.9 ± 0.94	55.5 ± 1.31	13.7 ± 0.93	60.8 ± 0.87	9.15 ± 0.62	60.6
Rate of oxygen consumption, percentage of standard	88.5 ± 0.61	6.9 ± 0.43	88.1 ± 0.92	10.7 ± 0.65	91.4 ± 0.91	9.7 ± 0.64	89.3
Schneider index, score.....	11.9 ± 0.32	3.28 ± 0.22	12.6 ± 0.23	2.56 ± 0.16	12.0 ± 0.30	2.96 ± 0.21	12.2
Galactose tolerance, Gm.	20.3 ± 0.6	6.7 ± 0.42	22.5 ± 0.9	9.5 ± 0.63	24.3 ± 0.6	6.1 ± 0.42	22.4
Gastro-intestinal emptying time, hours:							
Stomach	4	.....	4	.....	4	.....	4
Ileum	14 ± 1.4	.....	11 ± 0.5	5 ± 0.3	10 ± 0.5	5 ± 0.4	12
Cecum	49 ± 1.3	16 ± 0.9	46 ± 1.0	12 ± 0.7	43 ± 1.1	12 ± 0.8	46
Colon	76 ± 2.2	26 ± 1.5	70 ± 2.0	25 ± 1.4	76 ± 2.3	25 ± 1.6	74
Rectum	96 ± 2.6	31 ± 1.8	84 ± 2.2	25 ± 1.5	82 ± 2.5	27 ± 1.8	87
Urine:*							
Volume, cc.	2,496 ± 101	1,707 ± 71	2,387 ± 87	1,449 ± 62	2,602 ± 120	1,851 ± 85	2,495
Total solids, Gm.	59.3 ± 1.23	20.6 ± 0.87	62.0 ± 1.53	25.3 ± 1.08	69.5 ± 1.50	23.2 ± 1.06	63.8
Total nitrogen, Gm.	10.3 ± 0.2	3.4 ± 0.14	11 ± 0.23	3.7 ± 0.16	12.2 ± 0.19	3.0 ± 0.14	11.3
Urea nitrogen, Gm.	9.3 ± 0.17	2.8 ± 0.12	9.2 ± 0.20	3.3 ± 0.14	10.2 ± 0.18	2.7 ± 0.13	9.6
Creatinine nitrogen, Gm.	0.46 ± 0.006	0.129 ± 0.005	0.49 ± 0.009	0.146 ± 0.006	0.55 ± 0.007	0.116 ± 0.005	0.50
Residual nitrogen, Gm.	0.73 ± 0.02	0.35 ± 0.01	0.87 ± 0.02	0.31 ± 0.01	0.66 ± 0.02	0.31 ± 0.01	0.69

Blood morphology:							
Erythrocytes, thousands	4,900 ± 30	377 ± 22	4,800 ± 38	425 ± 26	5,170 ± 45	458 ± 32	4,957
Leukocytes, per cent	9,650 ± 241	2,833 ± 170	10,420 ± 226	2,570 ± 159	11,360 ± 382	3,894 ± 272	10,477
Polymorphonuclears, per cent	59.5 ± 0.54	6.6 ± 0.4	59.4 ± 0.6	6.8 ± 0.4	60.0 ± 0.7	7.9 ± 0.6	59.6
Lymphocytes, per cent	33.9 ± 0.5	6.4 ± 0.4	32.1 ± 0.5	6.5 ± 0.4	31.6 ± 0.7	7.5 ± 0.5	32.5
Eosinophils, per cent	2.8 ± 0.12	1.5 ± 0.1	2.6 ± 0.13	1.7 ± 0.1	2.5 ± 0.13	1.5 ± 0.1	2.6
Transitionals, per cent	4.2 ± 0.14	1.6 ± 0.1	5.4 ± 0.16	1.9 ± 0.1	6.4 ± 0.18	1.8 ± 0.10	5.3
Basophils, per cent	0.76 ± 0.04	0.62 ± 0.02	0.84 ± 0.04	0.57 ± 0.02	0.56 ± 0.01	0.16 ± 0.01	0.72
Hematocrit reading	45.4 ± 0.31	3.12 ± 0.22	44.0 ± 0.32	3.22 ± 0.22	45.4 ± 0.31	3.11 ± 0.22	44.9
Hemoglobin, Gm. per 100 cc.	15.2 ± 0.07	0.7 ± 0.05	15.2 ± 0.08	0.9 ± 0.05	15.5 ± 0.07	0.9 ± 0.05	15.3
Blood:							
Nonprotein nitrogen, mg.	32.2 ± 0.28	3.3 ± 0.20	33.9 ± 0.28	3.3 ± 0.2	33.1 ± 0.27	2.9 ± 0.19	33.1
Urea nitrogen, mg.	14.3 ± 0.22	2.6 ± 0.15	15.7 ± 0.19	2.2 ± 0.14	14.8 ± 0.17	1.8 ± 0.12	14.9
Amino-acid nitrogen, mg.	6.0 ± 0.03	0.44 ± 0.03	6.0 ± 0.03	0.49 ± 0.02	5.9 ± 0.03	0.41 ± 0.02	6.0
Uric acid, mg.	3.7 ± 0.03	0.52 ± 0.02	4.1 ± 0.03	0.46 ± 0.02	4.1 ± 0.04	0.55 ± 0.03	4.0
Uric acid nitrogen, mg.	1.25 ± 0.01	0.15 ± 0.01	1.36 ± 0.01	0.13 ± 0.01	1.39 ± 0.01	0.16 ± 0.01	1.33
Creatinine, mg.	1.37 ± 0.01	0.09 ± 0.004	1.36 ± 0.01	0.08 ± 0.003	1.32 ± 0.01	0.08 ± 0.004	1.33
Creatinine nitrogen, mg.	0.50 ± 0.00	0.012 ± 0.00	0.49 ± 0.00	0.012 ± 0.00	0.48 ± 0.00	0.012 ± 0.00	0.49
Creatine, mg.	3.89 ± 0.03	0.54 ± 0.02	3.97 ± 0.03	0.55 ± 0.02	3.94 ± 0.04	0.57 ± 0.03	3.93
Creatine nitrogen, mg.	1.18 ± 0.01	0.18 ± 0.01	1.21 ± 0.01	0.20 ± 0.01	1.19 ± 0.01	0.19 ± 0.01	1.19
Residual nitrogen, mg.	9.0 ± 0.35	3.0 ± 0.25	9.0 ± 0.23	2.2 ± 0.18	9.7 ± 0.22	2.4 ± 0.16	9.2
Blood sugar, mg.	99.3 ± 0.8	8.7 ± 0.5	96.5 ± 0.8	8.6 ± 0.5	93.1 ± 0.6	6.8 ± 0.4	93.0
Cholesterol, mg.	146 ± 2.1	24 ± 1.5	161 ± 1.9	23 ± 1.4	166 ± 1.7	17 ± 1.2	158.0
Plasma volume, cc.	2,587 ± 68	451 ± 48	2,546 ± 34	379 ± 24	3,024 ± 44	415 ± 31	2,719
Blood volume, cc.	4,787 ± 111	737 ± 79	4,845 ± 104	694 ± 74	5,097 ± 72	684 ± 51	4,910
Sedimentation rate, mm. per minute	0.22 ± 0.01	0.14 ± 0.01	0.24 ± 0.02	0.19 ± 0.01	0.29 ± 0.02	0.16 ± 0.01	0.25
Arterial oxygen, per cent by volume	17.4 ± 0.26	3.00 ± 0.18	18.0 ± 0.25	2.64 ± 0.17	18.7 ± 0.19	2.00 ± 0.4	18.0
Venous oxygen, per cent by volume	8.7 ± 0.27	3.22 ± 0.47	9.3 ± 0.27	3.06 ± 0.19	9.4 ± 0.29	3.05 ± 0.21	9.1
Arterial carbon dioxide, per cent by volume	50.2 ± 0.34	3.92 ± 0.24	49.2 ± 0.40	4.3 ± 0.28	49.5 ± 0.35	3.63 ± 0.25	49.6
Venous carbon dioxide, per cent by volume	58.5 ± 0.35	4.21 ± 0.25	58.6 ± 0.46	5.3 ± 0.33	58.0 ± 0.40	4.17 ± 0.28	58.4
Arterial p_{H_2}	.....	.....	.....	.....	7.42 ± 0.005	0.061 ± 0.004	.....
Venous p_{H_2}	.....	.....	.....	.....	7.35 ± 0.005	0.061 ± 0.004	.....

* Proportion of catheterized specimens progressively increased from period to period.

before arising and at about 4 p. m. H. E. C.'s morning temperature repeatedly was as low as 97 F. or less. It conformed rather closely to the group average of 97.6 F. The rates that prevailed by the time the metabolism laboratory had been reached (about 9 a. m.) varied from 98.2 to 99.4 F. This fact casts doubt on the actual basality of the patient's condition in the laboratory; the true basal rate may have been lower than that recorded.

TABLE 2.—*Respiratory Complex and Associated Data*

Variable	First Period 8/18/31	Second Period		Third Period	
		11/29/31	11/10/31	1/21/32	2/2/32
Weight, Kg.	73.0	73.6	74.0	68.6	67.6
Volume of lung, per cent.	94	50	60	70	98
Nutritional index, per cent.	100	101	102	94	93
Height, cm.	175.1				
Sitting height, cm.	93.4				
Sitting height index, cm.	53.3				
	8/5/31	10/29/31		1/21/32	
"B. M. R."	97	71		66	
Blood pressure	96/58	104/70		110/56	
Pulse rate	48-50	44-44		36-42	
Temperature, F.	99.2	98.2		98.8	
Respiratory rate	14-15-14	15-15-14		13-14-14-14	
	8/6/31	10/30/31		1/22/32*	
"B. M. R."	89	76		77	
Blood pressure	122/78	96/60		98/52	
Pulse rate	54-52	44-42		34-38	
Temperature, F.	99.4	98.4		99.0	
Respiratory rate	16-17-16	14-14-13		16-15-16	
	8/7/31	10/31/31		1/23/32	
"B. M. R."	100	72		69	
Blood pressure	116/68	94/50		98/56	
Pulse rate	54-54	40-40		33-35	
Temperature, F.	99.2	98.0		98.8	
Respiratory rate	20-20-20	12-13-13		12-13-13	
	8/18/31	11/10/31		2/2/32†	
"B. M. R."	81	76		71	
Blood pressure	108/80	94/48		110/66	
Pulse rate	44-46	50-50		44-48	
Temperature, F.	98.2	99.0		98.8	
Respiratory rate	20-24-24	12-14-16-15		10-10-11-12	

* "B. M. R." ("basal" metabolic rate): During this test workmen overhead were making a great deal of noise. The patient was restless and wandered about the room before he could be persuaded to lie down. He said that he did not want to take the test.

† "B. M. R.": A great deal of hammering overhead was continuous and disturbing. The patient apparently was calm, however.

On the other hand, the pulse rates obtained during the laboratory tests were comparable with the morning rates in the ward. The ranges in the laboratory were from 33 to 54 and in the ward, from 39 to 54. From this comparison it would seem that an excellent degree of mental and physical relaxation was obtained during the tests. The pulse rate of H. E. C. was distinctly lower than the average for the series, which was 59.2.

The so-called basal systolic blood pressure, as is characteristic of schizophrenic subjects, was remarkably variable. It ranged from 94 to 122 mm. of mercury as compared with an average rate for the entire series of 101.8 mm. Another remarkable feature is the lack of correlation between the blood pressure and the rate of oxygen consumption. Thus on Jan. 21, 1932, with a pressure of 110, the rate

was 66 per cent, while on Nov. 10, 1931, the pressure was 16 mm. lower, but the rate of oxygen consumption was 10 points higher. Such findings are not uncommon in individual cases, though in the series as a whole there is a significant degree of correlation between the two data. But the correlation between the steadiness and frequency of respiratory excursions on the one hand and the rate of oxygen consumption on the other was positive. On Feb. 2, 1932, the excursions were from 10 to 12 per minute and the rate of oxygen consumption was 71, whereas on Aug. 18, 1931, excursions, twice as frequent, i. e., from 20 to 24, were associated with a rate of oxygen consumption of 81.

If one attempts to take into consideration the various accessory findings that may serve as an index of the degree of basality prevailing during the various tests and to deduce the probable value of this patient's actual basal rate, one finds oneself in a quandary. First, there seems to be a systematic gradual fall of the rate during the total period of study. As between the two last subperiods, this drop coincides with a decrease in weight and might be thought to correlate with the patient's state of nutrition. As between the first two subperiods, however, no such relationship is evident.

Changes in weight are likely to be due to changes in assimilation of food. Such changes, especially in the assimilation of protein food, in turn might influence the "specific dynamic action" factor. There is a common belief that the basal rate varies with a level of consumption of protein, through the operation of the "specific dynamic effect" of the circulating amino-acids. In an unpublished analysis of a group of nonpsychotic control subjects we have found such a relationship throughout the range of consumption of protein, but in schizophrenic subjects the correlation between the two features is practically nil. We have not investigated the relationship of foodstuffs other than protein to the rate of the oxygen consumption, but if protein is ineffective, other foodstuffs will also probably prove to be so.

The question whether the shift in the rate of oxygen consumption was due to a change in the severity of the psychosis is expressly reserved for a future report. In the current connection, to ascribe it to such a cause would be to beg the question.

With these conditions in mind, what shall be our selection as representing the patient's basal metabolic rate? As is well known, the errors of technic in this particular test are nearly all in the upward direction. The use of spent soda lime and the aspiration of air around the mouthpiece are the two exceptions. The former error was rigidly excluded by actual tests of the reagent, and the technicians were especially on their guard to forestall the latter. It is altogether probable, therefore, that the lower rates recorded represent the nearest approach to the true basal rate of this patient. Perhaps we can safely state that the patient's representative basal metabolic rate was at least as low as 70 per cent and possibly materially below that level. In this respect the patient is not representative of the series, in which the average rate of oxygen consumption was found to be 89.3 per cent. The problem of oxygen consumption in schizophrenia has been further discussed elsewhere.^{1b}

Studies of the Urine (table 3).—These demand one item of special comment. As a routine measure, the patients are kept under surveillance during the entire time of the collection. However, there is an important source of error not thus provided for. Even in the case of the most docile and cooperative patient, one cannot be certain that the initial voiding that precedes the collection has completely emptied the bladder or that at the last voiding urine has not been retained. Accordingly, in every case at least two specimens have been obtained by the use of a catheter, instead of depending on the cooperation of the patient for the first and the last voidings of any given twenty-four hour collection. In addition, the

reliability of the collection can be roughly estimated by the creatinine content. Our patients subsist on a fairly uniform diet, so far as exogenous sources of creatinine are concerned, and reliable collections show this datum fluctuating within fairly narrow limits. Checking the creatinine values of the catheterized specimens against the "voluntary" specimens permits detection of the larger degrees of error. As a fact, we have determined the self-correlation of the creatinine in a large series of analyses, on some noncatheterized specimens, some partly catheterized specimens and some made up entirely of catheterized specimens. The rise in self-correlation as the number of catheterized samples increases is so marked as to indicate that errors of collection in psychotic patients are an important consideration in all quantitative studies of this sort. Unless several consecutive days' collections are made and the findings averaged, voluntary voidings are absolutely unreliable.

Looking first at the values for creatinine nitrogen (table 3) in the six samples analyzed in relation to the last two—catheterized—specimens, it is seen that the first three are entirely unreliable and the fourth probably represents more than a twenty-four hour output. The average value for creatinine of the last two

TABLE 3.—*Studies on the Urine, Twenty-Four Hour Collections*

Variable	First Period		Second Period		Third Period Catheterized Specimens	
	8/16/31	8/18/31	11/8/31	11/10/31	1/31/32	2/2/32
Volume, cc.	1,960	1,560	1,660	1,350	510	1,350
Total solids, cc.	78	58	70	38	36	44
Total nitrogen, cc.	16.9	11.7	11.5	9.7	6.5	8.6
Urea nitrogen, Gm. per 100 cc. .	14.3-34.3	9.9-84.9	8.9-77.8	7.8-80.5	4.8-72.8	6.9-80.5
Creatinine nitrogen, Gm. per 100 cc.	0.82- 4.8	0.64- 5.5	0.66- 5.3	0.53- 5.5	0.37- 5.7	0.46- 5.3
Residual nitrogen, Gm. per 100 cc.	1.2 - 6.9	0.6 - 5.4	1.6 -13.7	1.1 -10.9	0.5 - 8.0	0.8 - 9.8
Specific gravity.....	1.017	1.016	1.018	1.012	1.030	1.014
Indican.....	0	0	0	0	0	0
Urobilinogen.....	0-0	0-0	S.P.T.-0	0	Faint trace-0	0-0
Albumin.....	Faint trace	..	..	..	..	Trace
Sediment.....	Normal	Normal	Normal	Normal	Normal	Normal

specimens is 0.41 Gm., or 5.5 per cent of the total nitrogen. The average volume of the last two specimens was 930 cc., or 38 per cent of the average volume for our total series, which was 2,495 cc.

That the latter value is reliable and essentially representative is shown by a study on forty-four patients from whom the collections were all controlled by catheter. In this group the average volume was 2,602 cc., with a standard deviation of 1,851 cc. The study was controlled by samples from twenty-six normal subjects living in the same environment. Of these, the average volume of the twenty-four hour output was 1,328 cc., and the standard deviation, 629 cc. Thus it appears that the average urinary volume of schizophrenic patients is about twice the normal amount, and the individual variability is three times as great. In individual patients we have often obtained volumes of from 3 to 8 liters a day. In forty-eight of sixty-three patients carefully studied, the average volume was above the conventional high normal of 1,500 cc. These findings were entirely unexpected, and their significance is by no means clear. They suggest a high incidence of disturbed function of either the diencephalon or the posterior lobe of the pituitary gland.

The calculated datum for total solids in H. E. C. was significantly low. The average value for the two catheterized specimens was 40 Gm., as compared with the group average of 63.8 Gm.

In the catheterized specimens the total nitrogen averaged 7.5 Gm., which represents a total protein catabolism of approximately 48 Gm., an amount well below proper maintenance level. If each of the data of the four preceding tests are corrected to a creatinine value of 0.41, the total nitrogen averages 7.6 Gm., representing a total protein catabolism of 49 Gm. We thus have evidence that the patient's protein metabolism was at a subnormal level. In a previous paragraph the evidence was cited that this does not account for the depressed oxygen metabolic rate as it would in a measure in nonpsychotic patients. The residual nitrogen, a constituent that may show high values in certain conditions of disordered metabolism, was at a high normal level. The absence of significant metabolic intoxication suggested by this value is further supported by the consistent absence of indican in the urine. Since auto-intoxication has often been postulated as a cause of schizophrenia, these findings are interesting in their negative aspect. It will be noted in a subsequent paragraph that the patient showed considerable cecal stasis, a condition definitely favorable to putrefactive changes—hence indicanuria—had such been a factor in this case. As regards total nitrogen, the patient was not representative of the group, in which the average value was 11.3 Gm.

TABLE 4.—*Blood Morphology*

Variable	First Period		Second Period		Third Period	
	8/6/31	8/20/31	11/6/31	11/12/31	1/29/32	2/4/32
Erythrocytes.....	4,410,000	4,520,000	4,210,000	4,160,000	4,630,000	4,180,000
Hemoglobin.....	.....	18.5	14.5	15.0	15.5	14.0
Leukocytes.....	8,800	10,300	12,800	13,450	15,200	12,500
Polymorphonuclears.....	54	56.5	67	64.5	63	73.5
Lymphocytes.....	42	36.5	21.5	27.5	31.5	18
Transitionals.....	3.5	6	6	4	3	6.5
Eosinophils.....	0	0.5	4	3	2	2
Basophils.....	0.5	0.5	1.5	1	0.5	0
Schilling index:						
Senior.....	.....	55.5	57	60.5	61.5	73
Stab cells.....	.....	1	5.5	4	1.5	0.5
Junior.....	.....	0	0	0	0	0
Myelocytes.....	.....	0	0	0	0	0

The faint trace of urobilinogen in the fifth specimen is probably of negligible significance, as is the faint trace of albumin in two samples. The sediments were not abnormal, evidence that genito-urinary disease was not a complicating factor.

The galactose tolerance varied from 20 to 40 Gm. According to Rowe,³ this is precisely the range in normal subjects. We are unable to interpret the findings beyond suggesting that they may indicate an unsteady hepatic function. The average galactose tolerance for the entire series was 22.4 Gm. as compared with Rowe's average of 30 Gm. for normal males.

Morphology of the Blood.—Studies revealed (table 4) consistently a moderate secondary anemia, the erythrocytes averaging 4,351,000. The patient, a well nourished man, aged 31, would be expected to have a count above 5,000,000. The values for hemoglobin in general were in harmony with the erythrocyte counts. In this regard the patient was not entirely representative of the series in which the average red cell count was 4,957,000; the trend of the group as a whole was downward. There was a moderate and variable leukocytosis, which was characteristic of the series as a whole, averaging 10,477 cells per cubic millimeter. The number of white cells varies with posture and emotional tension, neither of which

3. Rowe, A. W.: The Metabolism of Galactose: I. The Threshold of Tolerance in Normal Adults, *Arch. Int. Med.* **34**:388 (Sept.) 1924.

was adequately controlled in this series. The normal Schilling formula tends to rule out infection as a cause. The sedimentation rate of the blood in many patients with similar degrees of leukocytosis has failed to give any indication of infection.

Variability in the differential leukocyte counts is striking and unexplained. The polymorphonuclear proportion averaged slightly high in comparison with the average of our seven months' series, in which it was 59.6 per cent. The Schilling index shows an absence of the shift of the formula that is said to indicate intoxication or infection. In this respect, too, the patient was typical of the entire series.

TABLE 5.—*Chemical Analysis of Blood* *

Variable	First Period		Second Period		Third Period	
	8/6/31	8/18/31	10/29/31	11/13/31	1/21/32	2/4/32
Total nonprotein nitrogen.....	49	34	32	37	36	32
Urea nitrogen.....	21	14	14	18	20	16
		41	44	49	56	50
Amino-acid nitrogen.....	..	..	5.4	6.7	5.7	5.6
			17	18	16	18
Uric acid.....	4.1	4.2	4.1	4.0	4.4	3.9
Uric acid nitrogen.....		1.4	1.4	1.3	1.5	1.3
		4	4	4	4.2	4.1
Creatinine.....	1.4	1.4	1.4	1.4	1.3	1.3
		0.52	0.52	0.52	0.48	0.48
Creatinine nitrogen.....		2	2	1.4	1.3	1.5
Creatine.....	..	3.5	3.6	4.3	3.1	3.7
Creatine nitrogen.....	..	1.12	1.15	1.38	0.99	1.19
		3	4	4	2.8	3.7
Residual nitrogen.....	..	..	9.53	9.10	7.33	7.43
			30	25	20	23
Sugar.....	116	95	111	101	91	88
Cholesterol.....	..	..	176	..	148	148
			11/6		1/29	
Plasma volume.....			2,791		3,475	
Blood volume.....			5,260		5,620	
p_{H}					A. 7.53, V. 7.23	
Arterial oxygen.....			17.24		16.96	
Venous oxygen.....			6.39		6.72	
Arterial carbon dioxide.....			51.18		49.28	
Venous carbon dioxide.....			64.55		60.25	

* The results are in milligrams per hundred cubic centimeters, and, in the case of nitrogen fractions, in percentage of the total.

Analyses of the Blood.—The findings (table 5) for the most part were not remarkable either in the case cited or in the entire series and call for little comment. They were mostly within normal limits but showed a rather marked shift from test to test. The total nonprotein nitrogen of the patient averaged 37 mg., as compared with the group average of 33 mg. The uric acid, determined by the Francke-Benedict method for this patient, was 4.1 mg.; the average for the group was 4 mg. The average for thirty-one normal control subjects was 3.9 mg. The cholesterol content trended somewhat low, as did the average value for the entire series, namely, 158 mg. per hundred cubic centimeters. A rather striking anomaly was the low value of the venous oxygen. This seems to indicate slowing of the peripheral circulation; this is borne out, in the case under consideration, by the high venous carbon dioxide, but in other cases the data were not so consistent. In view of recent attempts to explain the psychosis in terms of dispersion of the circulating and the brain cell colloids, it is of interest that the p_{H} of the blood in this patient, as in the whole series, was normal.

Cardiovascular Tests.—The data (table 6) suggest why the characteristic basal hypotension of schizophrenic patients has commonly been overlooked. The tests were made in the afternoon when the patient was actively adjusting to his environment. The systolic blood pressure ranged from 115 to 131 mm. of mercury, whereas the basal blood pressure was below 100 mm. Were the afternoon values the only ones available, the patient would unquestionably be reported as having a normal blood pressure. This would be borne out by the Schneider index, which was within normal limits—indeed well toward the upper normal value that is shown by trained athletes in the pink of physical fitness. We do not regard the favorable showing in these tests as truly mirroring the degree of physical fitness of the patients.

Hepatic Function.—This was tested in several ways. Bromsulphthalein excretion was not affected in the case of H. E. C., the findings being consistently normal as in practically all the cases. In two of the six twenty-four hour samples of urine, the slightest possible trace of urobilinogen was found. McClure's test

TABLE 6.—*Cardiovascular Test*

Variable	First Period 10/5/31	Second Period 11/6/31	Third Period 1/29/32
Systolic pressure, mm.	115	131	125
Diastolic pressure, mm.	75	84	85
Pulse rate.	48	45	40.5
Schneider Index.....	15-16	12-15	12

TABLE 7.—*Gastro-Intestinal Motor Functions*

Emptying Time, Hours	First Period 9/25/31	Second Period 11/17/31	Third Period 2/9/32
Stomach.....	4	4	4
Ileum.....	12	9	48
Cecum.....	72	72	72
Colon.....	168	96	120
Rectum.....	168	120	120

was carried out on two occasions within a few months after the seven months' study was completed. With both tests the cholesterol was normal in amount. In the first collection the furfural number was low, and the level of the bile pigments was normal. At the second examination, the furfural number was normal and the pigments low. We have found in many cases of schizophrenia that the biliverdin content is low, with the findings normal in other respects. This suggests a lowering of oxygenation processes. The Graham test findings, van den Bergh reaction and icteric index were all normal at the time of testing.

On the basis of these tests, we are perhaps justified in assuming an inconstant diminished level of hepatic efficiency. Various functions of the liver were apparently affected at different times. The same statements can be made regarding the series as a whole.

Gastro-Intestinal Function.—Roentgen studies of H. E. C. (table 7) indicated normal motor functions in the upper part, but fairly marked stasis in the lower part of the bowel. The prolonged retention of barium sulphate in the ileum in the third period is anomalous and not explained. As compared with the average values for the entire series, the delay is accentuated in both the cecum and the colon, averaging seventy-two and one hundred and twenty-six hours, respectively, in the one case,

and forty-six and seventy-four hours in the other. The retention of the rectal contents averaged one hundred and thirty-six hours in the patient and eighty-seven hours in the total series. The constipation thus indicated is probably of little or no physiologic importance. Altogether, according to these findings, the gastrointestinal motor functions of schizophrenic patients are not significantly abnormal above the cecum, but from this level down a considerable degree of sluggishness commonly occurs. To that extent the old idea of intestinal auto-intoxication as a characteristic of the psychosis is supported. However, the stasis is rarely accompanied by significant putrefactive activity, so far as can be judged by the formation of indican; we have made routine tests for indicanuria, but seldom have obtained positive responses. Furthermore, Macht's test with *Lupinus albus* has failed to disclose any significant evidence of intoxication. As further negative evidence we may cite the fact that neither saline cathartics nor prolonged treatment with *Bacillus acidophilus* has shown any noteworthy beneficial effect on the symptomatology in small groups in which they were employed systematically.

COMMENT

The evidence brings out two sorts of abnormality as characteristic of schizophrenia. Most noteworthy, perhaps is the high degree of vari-

TABLE 8.—*Extreme Values in Case Reported*

Variable	Values	
Rate of oxygen consumption, per cent.....	100	66
Blood pressure, mm.	122	94
Pulse rate	54	34
Temperature (rectal), F.	99.2	96.6
Volume of urine, cc.	1,960	510
Galactose tolerance, Gm.	40	20
Erythrocytes	4,160,000	4,630,000
Leukocytes	15,200	10,300
Lymphocytes, per cent.....	42	18
Blood nitrogen, mg.	49	32
Blood sugar, mg.	116	88
Emptying time of colon, hours.....	168	96

ability of many of the bodily functions. In table 8 are noted the extreme values in a few of these, as exemplified in H. E. C. If we had had available only single tests, the patient might have been characterized, as a matter of random chance, by values falling anywhere between the extremes noted. He thus might have seemed to be either essentially normal, physiologically, or grossly abnormal. The findings serve to bring into sharp relief the futility of researches based on single tests, so far as individual patients are concerned. Such tests are valid solely for the purpose of striking group averages in which high and low values compensate.

Not only is the average schizophrenic patient a highly variable person as regards physiologic functions, but certain of these are basically abnormal. Cannon pointed out as a fundamental biologic principle the fact that efficiency—indeed, even survival—is dependent on the operation of a multiplicity of mechanisms for the maintenance of a “steady

state" in the organism. This principle he has called "homeostasis."⁴ In 1931, on the basis of data then available, the prediction was ventured that schizophrenia would prove to be characterized by abnormal homeostasis.^{1a} It was suggested that this might involve abnormalities in the response to stimuli as well as organization at displaced (pathologic) levels. The data obtained in the current study seem to substantiate both aspects of the suggestion. Further discussion of this generalization will be deferred until the findings regarding the various functions have been reported in further detail.

SUMMARY

An epitomized account is given of the results of a study of the physiologic functions in schizophrenia as brought out by repeated tests on fifty-seven male subjects over a period of seven months. An illustrative case history is included.

The average age of the patients was 31.7 years, and the period of hospitalization, five and nine-tenths years. Recent acute cases as well as old chronic cases were sparsely represented.

Grossly, the patients in most respects were organically normal. They averaged 16 per cent underweight and as a group showed a high incidence of poor circulation of the skin, irregularities of the pupils, abnormal reflexes and poor teeth.

The blood pressure, the rate of oxygen consumption and, to a slight extent, the pulse rate were basically depressed. The level of protein metabolism showed no significant correlation with the rate of oxygen consumption as it did in a control series. This group of findings serves to indicate hypometabolism as a characteristic condition.

The urinary constituents were normal in amount, as was the distribution of the nitrogenous components, but the total volume was twice the normal amount and the variability of output three times as great as in a control series of samples from normal subjects. This finding suggests abnormal functioning of the diencephalon or of the posterior lobe of the pituitary gland.

The galactose tolerance was notably variable, from 20 to 40 Gm. in most cases, with a group average of 22.4 Gm. as compared with a reported normal average of 30 Gm. The blood sugar during fasting, on the other hand, was strictly normal in both average and range.

The blood pictures were characterized by a high incidence of moderate secondary anemia and leukocytosis. The average red and white cell counts were 4,957,000 and 10,477, respectively. The differential counts averaged substantially normal. The sedimentation rate and Schilling

4. Cannon, W. B.: Organization for Physiological Homeostasis, *Physiol. Rev.* 9:399 (July) 1929.

indexes were commonly normal. The chemical constituents of the blood were unusually variable in individual cases, but the averages were mostly normal. The cholesterol content ranged slightly low. In individual cases the venous oxygen was strikingly low, but the average was substantially normal.

The Schneider index was normal, giving a factitious appearance of physical fitness.

The functional efficiency of the liver, tested in a variety of ways, indicated a variable and inconsistent inefficiency in a considerable proportion of the cases.

Nearly all of the functions studied showed high individual variability.

CONCLUSION

As regards homeostasis, schizophrenia is characterized by two deviations from normality. The ability to maintain the "steady state" is diminished, and some functions are basically displaced in an upward, others in a downward, direction.